Phy 101

Chapter 12

Prepared by Abul Lais/Dr M.A. Gondal

Q16.
A solid copper sphere has a radius of 85.5 cm. How much stress should be applied to the sphere to reduce the radius to 85.0 cm? The bulk modulus of copper is 1.4×10^{11} N/m^2.

A) 2.4×10^9 N/m^2
B) 4.7×10^9 N/m^2
C) 3.6×10^9 N/m^2
D) 5.8×10^9 N/m^2
E) 6.6×10^9 N/m^2

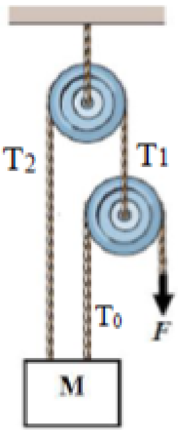
Solution:

$$\frac{F}{A} = B\frac{\Delta V}{V} = 1.4 \times 10^{11}\frac{85.5^3 - 85^3}{85.5^3} = 2.44 \times 10^9 N/m^2$$

191, Final, Q16

Q24.

A force F of magnitude 15 N, shown in the Figure 13, keeps the hanging block of mass M and massless pulleys in equilibrium. What is the mass M?



Solution:

$T_0 = F$

$T_0 + F = T_1 = 2F$

$T_2 = T_1 = 2F$

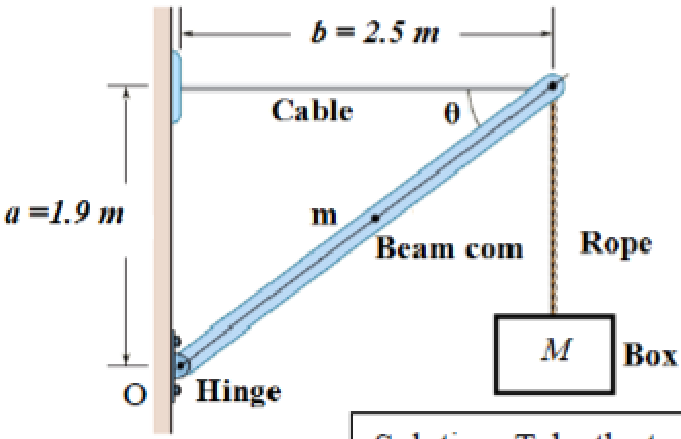
$T_0 + T_2 = Mg \Rightarrow F + 2F = Mg \Rightarrow M = \frac{3F}{g} = 4.6\ kg$

A) 4.6 kg
B) 2.2 kg
C) 5.2 kg
D) 5.8 kg
E) 6.2 kg

191, Final, Q24

Q25.

Figure 14 shows a box (M = 430 kg) hanging by a rope from a boom that consists of a uniform hinged beam (m = 85 kg) and a horizontal cable of negligible mass. The system is in equilibrium. What is the tension in the cable?



Solution: Take the torque about the point O

$$\tau = 0 = Ta - mg\left(\frac{b}{2}\right) - Mgb$$

$$T = \frac{mg\left(\frac{b}{2}\right) + Mgb}{a} = 6093\ N$$

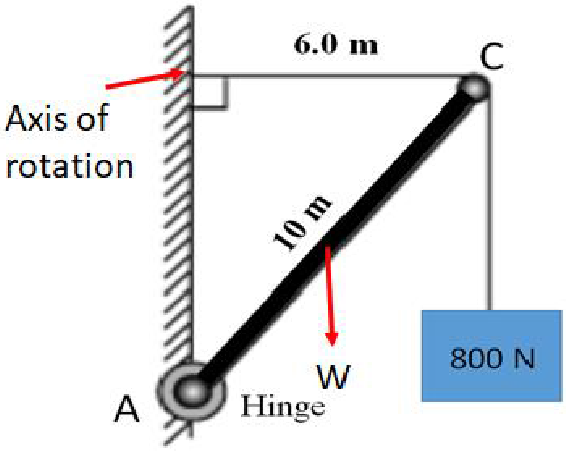
A) 6100 N
B) 6700 N
C) 7600 N
D) 8000 N
E) 8400 N

191, Final, Q25

Q14.

A 10-m long uniform rod (AC) of weight 400 N is hinged to a wall at A. It is supporting an 800-N block as shown in Figure 4. Find the magnitude of the hinge force.

Figure 4



A) 1.42×10^3 N
B) 3.50×10^2 N
C) 4.50×10^2 N
D) 5.06×10^3 N
E) 2.31×10^3 N

Ans:

$$W + 800 = F_v$$

$$F_v = 1200\ N$$

$$-400 \times 3 - 800 \times 6 + F_h 8 = 0$$

$$F_h = \frac{6000}{8} = 750\ N$$

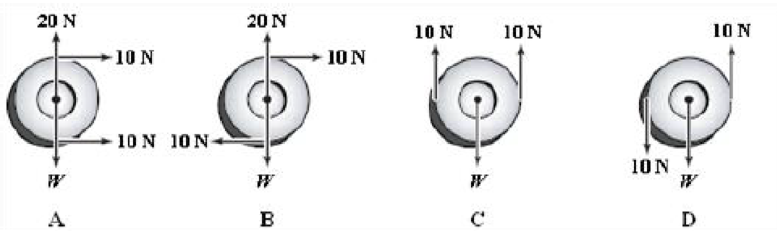
$$F = \sqrt{F_a^2 + F_h^2} = \sqrt{1200^2 + 750^2} = 1.42 \times 10^3 \text{N}$$

182, Final, Q14

Q15.

Figure 5 show forces applied to a wheel that weighs 20 N. The symbol W stands for the weight. In which diagram(s) is(are) the wheel in static equilibrium?

Figure 5



A) C
B) A
C) B
D) C and A
E) D

Ans:

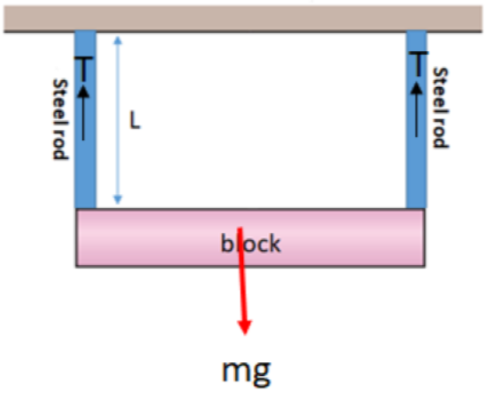
A

182, Final, Q15

Q16.

Figure 6 shows a uniform block which is held in a horizontal position by two vertical steel rods at its ends. Each of the rods has length, L = 1.0 m, cross sectional area of 1.0×10^{-3} m^2 and young's modulus of 2.0×10^{11} N/m^2. If the increase in the length of any one of the rods is 2.5×10^{-6} m, find the mass of the block.

Figure 6



A) 100 kg
B) 150 kg
C) 200 kg
D) 250 kg
E) 300 kg

Ans:

$$mg = 2T$$

$$T = \frac{mg}{2}$$

$$Y = \frac{\frac{T}{A}}{\frac{\Delta L}{L}} = \frac{mgL}{2A\Delta L}$$

$$m = \frac{2YA\Delta L}{gL} = 100 \text{ kg}$$

182, Final, Q16

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Q2.

A 30.0 kg hammer strikes, a steel nail 2.30 cm in diameter, vertically downward. During the strike, which lasted for 0.110 s, the magnitude of the change in momentum of the hammer was 900 kg.m/s. What is the average strain in the nail during the impact? (Young modulus E of steel = 20.0×10^{10} N/m^2)

A) 9.85×10^{-5}
B) 8.81×10^{-5}
C) 7.22×10^{-5}
D) 6.65×10^{-5}
E) 5.11×10^{-5}

Ans:

$$Force\ F = \frac{Change\ in\ momentum}{time} = \frac{900}{0.11} = 8182\ N$$

$$Avg.Strain = \frac{Stress}{E} = \frac{F/\pi r^2}{20\times10^{10}} = \frac{8182\ /\pi(0.0115)^2}{20\times10^{10}}$$

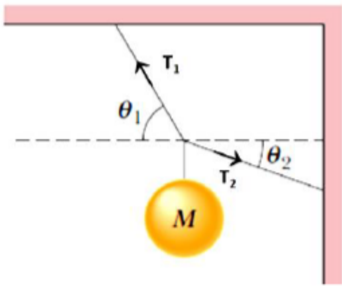
$$Avg.Strain = 9.846\times10^{-5}$$

181, Final, Q2

Q3.

A mass M = 5.0 kg , supported by two massless strings with tensions T_1 and T_2, as shown in **Figure 2**, is hanging vertically. The system is in equilibrium. The angles of strings are $\theta_1 = 70°$ and $\theta_2 = 30°$. What are the tensions T_1 and T_2 in the strings respectively?

Figure 2



A) 66 N; 26 N
B) 63 N; 21 N
C) 67 N; 26 N
D) 68 N; 28 N
E) 70 N; 16 N

Ans:

$$\sum F_x = T_2 cos\theta_2 - T_1 cos\theta_1 = 0$$

$$T_2 = T_1 \frac{cos70}{cos30} = 0.395\ T_1$$

$$\sum F_y = T_1 sin\theta_1 - T_2 sin\theta_2 - Mg = 0$$

$$T_1 = T_2 \cdot \frac{sin\theta_2}{sin\theta_1} + \frac{Mg}{sin\theta_1} = 0.395\ T_1 \times \frac{sin30}{sin70} + \frac{5\times9.8}{sin70}$$

$$T_1 = 0.21\ T_1 + 52.14 \Rightarrow T_1 = 66\ \text{N}$$

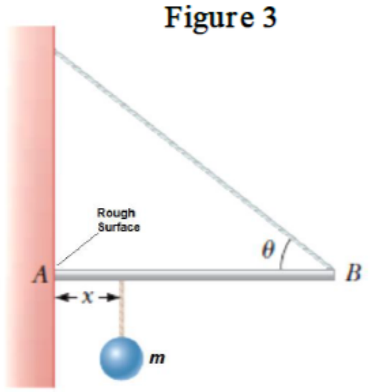
$$T_2 = 0.395\times T_1 = 26.07\ \text{N}$$

181, Final, Q3

Q4.

One end of a uniform 4.0 m long rod of 10 kg mass is supported by a cable at an angle of $\theta = 37°$ with the rod. The other end of the rod rests against the wall, where it is held by friction as shown in **Figure 3**. The coefficient of static friction between the wall and the rod is $\mu_s = 0.50$. Determine the minimum distance *x* from point *A* at which an additional mass m = 5.0 kg can be hung without causing the rod to slip at point *A*.

Figure 3



A) 3.2 m
B) 2.4 m
C) 2.9 m
D) 4.5 m
E) 5.9 m

Ans:

$$\sum F_x = 0 \Rightarrow n = T\cos\theta = T\cos 37 = 0.798\ \text{T}$$

$$\sum F_y = 0 \Rightarrow f_s + T\sin\theta = (m + M)g$$

$$f_s = \mu_s n$$

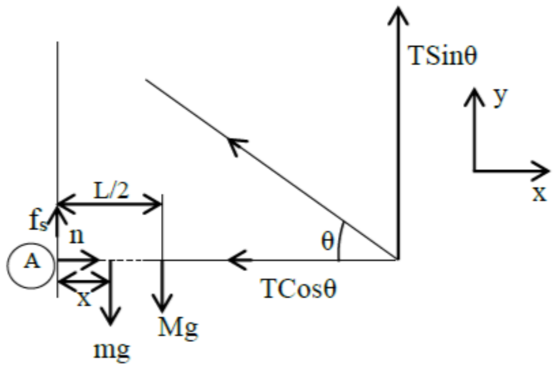
$$0.5 \times 0.798\, T + T\sin 37 = (5 + 10) \times 9.8$$

$$T = 147\ \text{N}$$

Taking torque about A

$$T\sin\theta L - Mg\frac{L}{2} - xmg = 0$$

$$x = \frac{2T\sin\theta - 2Mg}{mg} = 3.22\ m$$



181, Final, Q4

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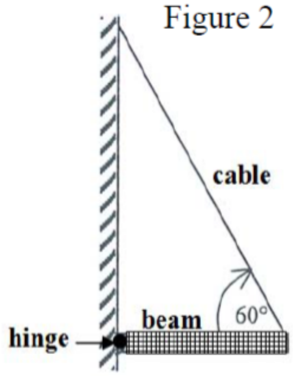
Q14.

A uniform horizontal beam of weight W is supported by a hinge and a cable, as shown in **Figure 2**. The vertical component of the force by the hinge on the beam is:

Figure 2



A) $W/2$, up
B) W, down
C) W, up
D) $W/2$, down
E) zero

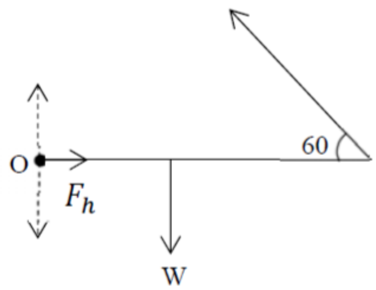
173, Final, Q14

Ans:

$$\sum \tau_0 = 0 :$$

$$-W\frac{L}{2} + T \cdot L\, sin60° = 0$$

$$\Rightarrow T = \frac{W}{2\, sin60°}$$



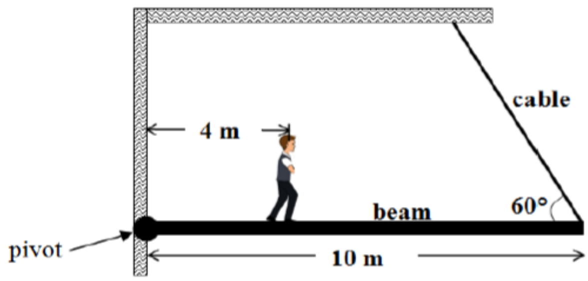
$$\sum F_y = 0 : Tsin60° - W + F_y = 0$$

$$\Rightarrow F_y = W - T\, sin60° = W - \left(\frac{W}{2\, sin60°}\, sin60°\right) = \frac{W}{2}\ (+) \rightarrow up$$

Q15.

Figure 3 shows a uniform horizontal beam (length 10.0 m, mass 25.0 kg) that is pivoted at the wall, with its far end supported by a cable that makes an angle of 60.0° with the horizontal. If a person, of mass 60.0 kg, stands 4.00 m from the pivot, what is the tension in the cable?

Figure 3

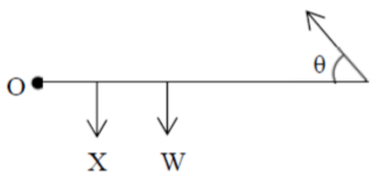


A) 413 N
B) 200 N
C) 830 N
D) 446 N
E) 390 N

Ans:

$$\sum \tau_0 = 0$$

$$(-X)(4) - (W)(5) + (T)(10)\sin 60° = 0$$



$$\Rightarrow T = \frac{4X + 5W}{10 \cdot \sin 60°} = \frac{[(4 \times 60) + (5 \times 25)] \times 9.8}{10 \times \sin 60°}$$

$$= 413\text{ N}$$

173, Final, Q15

Q16.

A cylindrical wire stretches 1.0 cm when a force is applied to it (perpendicular to its cross section). The same force is applied to another cylindrical wire of the same material but that has twice the radius and twice the length of the first wire. The second wire stretches by:

A) 0.50 cm
B) 0.25 cm
C) 1.0 cm
D) 2.0 cm
E) 4.0 cm

Ans:

$$1st\ Wire:\ \frac{F}{A} = E \cdot \frac{\Delta l}{l} \quad \left\{A = \pi r^2 = \pi \left(\frac{D}{2}\right)^2 = \frac{\pi D^2}{4}\right\}$$

$$F = \frac{\pi \cdot E \cdot \Delta l \cdot d^2}{4l} \rightarrow (1)$$

$$2nd\ Wire:\ F = \frac{\pi \cdot E \cdot \Delta L \cdot D^2}{4L} \rightarrow (2)$$

$$Divide\ (2)\ by\ (1): 1 = \frac{\pi \cdot E \cdot \Delta L \cdot D^2}{4L} \cdot \frac{4l}{\pi \cdot E \cdot \Delta l \cdot d^2}$$

$$1 = \frac{\Delta L}{\Delta l} \cdot \left(\frac{D}{d}\right)^2 \cdot \frac{l}{L} \Longrightarrow 1 = \frac{\Delta L}{\Delta l} \cdot \left(\frac{2d}{d}\right)^2 \cdot \frac{l}{2l}$$

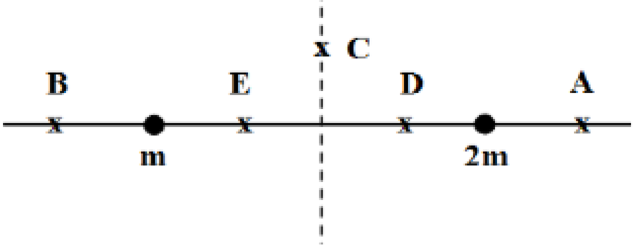
$$1 = \frac{\Delta L}{\Delta l} \times 4 \times \frac{1}{2} \Rightarrow \Delta l = 2\Delta L \Rightarrow \Delta L = \frac{\Delta l}{2} = \frac{1}{2}\ \text{cm}$$

173, Final, Q16

Q17.

Two particles, of masses *m* and 2*m*, are fixed in place on the *x*-axis, as shown in **Figure 4**. The net gravitational force, due to these two particles, on a third particle will possibly be zero when this particle is at point:

Figure 4



A) E
B) C
C) D
D) A
E) B

Ans:

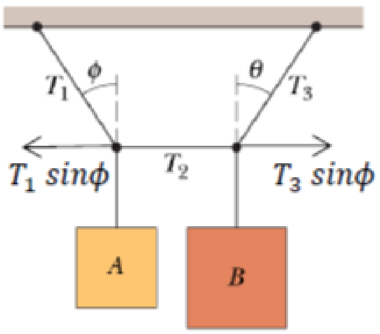
The point of equilibrium has to be on the x-axis between the two particles closer to the lighter one $\Longrightarrow$ Point E

173, Final, Q17

Q12.

The system in Figure 3 is in static equilibrium, with the string in the center exactly horizontal. Block A weighs 35 N, block B weighs 45 N, and angle ϕ is 35°. Find the magnitude of the tension (T_2) in the horizontal section of the string.

Figure 3



A) 25 N
B) 30 N
C) 15 N
D) 10 N
E) 35 N

Ans:

$$\frac{T_1 sin\phi}{T_1 cos\phi} = \frac{T_2}{35}$$

$$T_2 = 35tan\phi = 35 \times tan35° = 25\ N$$

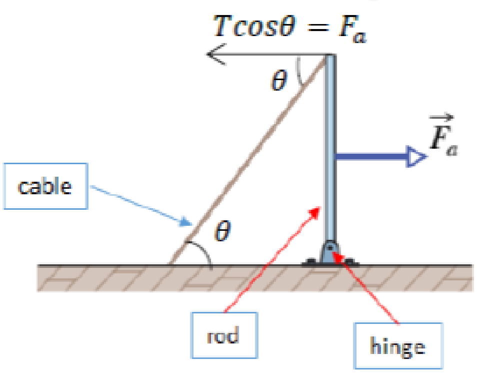
172, Final, Q12

Q13.

In Figure 4, a vertical rod is hinged at its lower end and attached to a cable at its upper end. A constant horizontal force ($\vec{F}_a$) is to be applied to the rod as shown. Assuming the rod remains in its vertical position, if the point at which the force is applied is moved up the rod, the tension in the cable:

Figure 4

A) increases
B) decreases
C) remains constant
D) first increases then decreases
E) first decreases then increases



Ans:

$Tcos\theta = F_a$

$rF_a = Tcos\theta L$

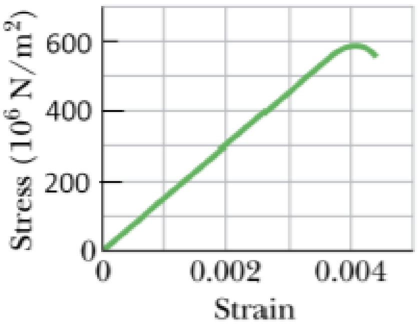
If r goes up it has to be balanced by T as θ, L and F_a are constant.

172, Final, Q13

Q14.

Figure 5 shows the stress–strain curve for a material. What is the Young's modulus of the material?

Figure 5



A) 1.5×10^{11} N/m^2
B) 6.0×10^4 N/m^2
C) 1.5×10^5 N/m^2
D) 2.4×10^{11} N/m^2
E) 2.4×10^5 N/m^2

Ans:

$$Y = \frac{Stress}{Strain}$$

$$= \frac{600 \times 10^6 - 0}{0.004 - 0}$$

$$Y = 1.5 \times 10^{11}\ N/m^2$$

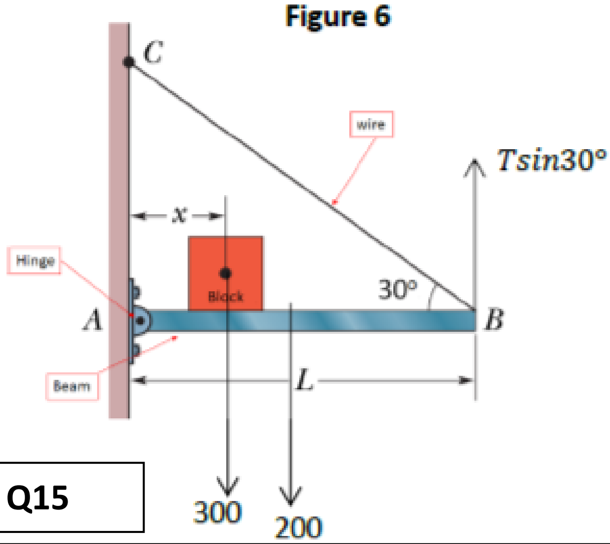
172, Final, Q14

Q15.

Figure 6 shows a uniform beam hinged to a wall and it is supported by a wire. Suppose the length L of the beam is 3.00 m and its weight is 200 N. A block of weight 300 N is placed on the beam at distance x from the wall. If the wire can withstand a maximum tension of 500 N what is the maximum possible distance x before the wire breaks?

A) 1.50 m
B) 2.00 m
C) 2.50 m
D) 3.00 m
E) 3.50 m

Figure 6



Ans:

$$Tsin30°L = 300x + 200\frac{L}{2}$$

$$300x = 500 \times \frac{1}{2} \times 3 - 200 \times \frac{3}{2}$$

$$x = 2.5 - 1 = 1.5\ m$$

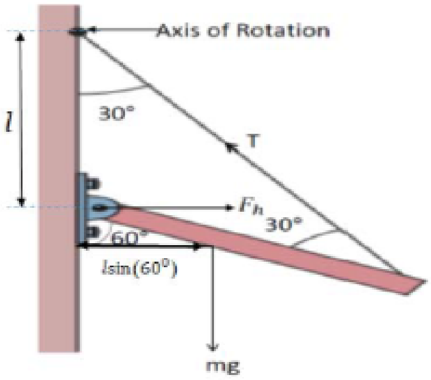
172, Final, Q15

Q13.

In **Figure 4**, one end of a uniform beam of weight 222 N is hinged to a wall; the other end is supported by a wire of negligible mass that makes angles θ = 30.0° with both wall and beam. Find the horizontal component of the force of the hinge on the beam

Figure 4

A) 96.1 N
B) 66.1 N
C) 41.3 N
D) 23.5 N
E) 87.3 N



Ans:

$$F_h l - \frac{l}{2} sin60° mg = 0$$

$$F_h = \frac{sin60° \times 222}{2} = 96.1\ N$$

171, Final, Q13

Q14.

Aluminum Rod 1 has a length L and a diameter d. Aluminum Rod 2 has a length $2L$ and a diameter $2d$. When Rod 1 is under tension T and Rod 2 is under tension $2T$, the changes in lengths of rods 1 and 2 are ΔL_1 and ΔL_2, respectively. Which one of the following is **TRUE**?

A) $\Delta L_2 = \Delta L_1$
B) $\Delta L_2 = 2\ \Delta L_1$
C) $\Delta L_1 = 2\ \Delta L_2$
D) $\Delta L_1 = 4\Delta L_2$
E) $\Delta L_2 = 4\Delta L_1$

Ans:

$$\frac{T}{\frac{\pi}{4}d^2} \cdot \frac{L}{\Delta L_1} = \frac{2T}{\frac{\pi}{4}(2d)^2} \cdot \frac{2L}{\Delta L_2}$$

$$\frac{1}{\Delta L_1} = \frac{4}{4}\frac{1}{\Delta L_2} \Rightarrow \Delta L_1 = \Delta L_2$$

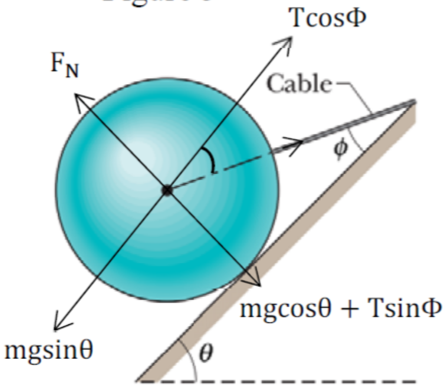
171, Final, Q14

Q15.

In **Figure 5**, a 10 kg sphere is supported on a frictionless plane inclined at angle $\theta = 45°$ from the horizontal. Angle ϕ is 25°. Calculate the tension in the cable.

A) 76 N
B) 35 N
C) 48 N
D) 52 N
E) 15 N

Figure 5



Ans:

$$T\cos\Phi = mg\sin\theta$$

$$T = \frac{mg\sin\theta}{\cos\Phi}$$

$$T = \frac{10 \times 9.8 \sin(45°)}{\cos(25°)} = 76\ N$$

171, Final, Q15

Q17.

One end of a plastic rope, of length 45.0 m and radius 3.50 mm, is fixed to a ceiling while the other end is free. Its length increases by 1.10 m when a mass of 65.0 kg is attached to its free end. What is Young's modulus for plastic?

A) 6.78×10^8 N/m^2
B) 4.69×10^8 N/m^2
C) 6.25×10^8 N/m^2
D) 2.83×10^8 N/m^2
E) 8.54×10^8 N/m^2

Ans:

$$\frac{F}{A} = E \cdot \frac{\Delta L}{L}$$

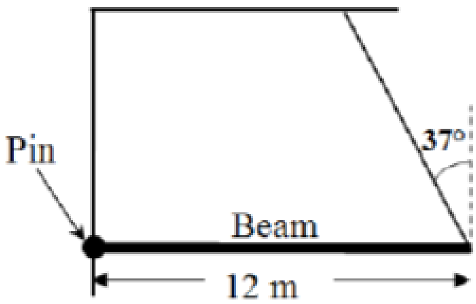
$$E = \frac{F \cdot L}{A \cdot \Delta L} = \frac{mgL}{\pi r^2 \cdot \Delta L} = \frac{65 \times 9.8 \times 45}{\pi \times (3.5)^2 \times 10^{-6} \times 1.1} = 6.78 \times 10^8\ \ N/m^2$$

163, Final, Q17

Q15.

A uniform beam has a weight of 120 N, and is supported as shown in **Figure 6**. What is the magnitude of the force by the pin on the beam?

Figure 6

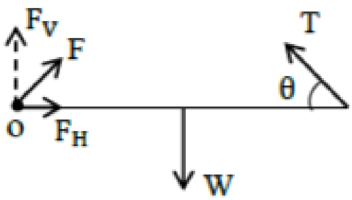


A) 75 N
B) 94 N
C) 88 N
D) 63 N
E) 90 N

Ans:

$$\sum \tau_o = 0:\ W \cdot \frac{L}{2} = T \cdot L \cdot \sin\theta$$

$$T = \frac{W}{2\sin\theta} = \frac{120}{2 \times \sin 53} = 75.1\ \text{N}$$



$$\sum F_x = 0:\ F_H = T\cos\theta = 45.2\ \text{N}$$

$$\sum F_y = 0: F_V = +W - T\sin\theta = W - \frac{W}{2} = \frac{W}{2} = 60\ \text{N}$$

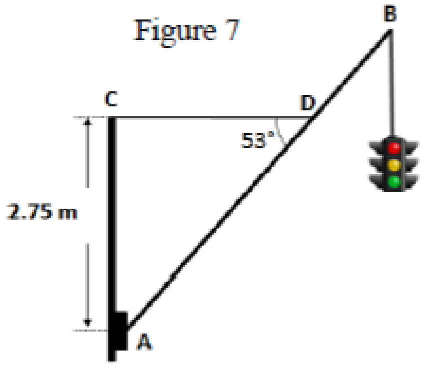
$$\Rightarrow F = \sqrt{(45.2)^2 + (60)^2} = 75\ \text{N}$$

163, Final, Q15

Q16.

A traffic light hangs from the structure shown in **Figure 7**. The uniform rod AB is 4.50 m long and has a mass of 5.00 kg. The mass of the traffic light is 10.0 kg. Determine the magnitude of the tension in the horizontal massless cable CD.

Figure 7



A) 121 N
B) 160 N
C) 91.0 N
D) 100 N
E) 145 N

Ans:

$$\sum \tau_A = 0:$$

$$5 \times 9.8 \times 2.25 \times \sin 37° + 10 \times 9.8 \times 4.5 \times \sin 37° = T \times 3.44 \times \sin 53°$$

$$\Rightarrow T = 121\ \text{N}$$

163, Final, Q16

Q11.

What increase in pressure is necessary to decrease the volume of a sphere by 0.23%? Take the bulk modulus of the sphere $B = 2.8\times10^{10}$ N/m^2.

A) 6.4×10^{7} N/m^2
B) 6.4×10^{9} N/m^2
C) 1.2×10^{7} N/m^2
D) 1.2×10^{9} N/m^2
E) 5.7×10^{10} N/m^2

Ans:

$$B = \frac{p}{\frac{dV}{V}}$$

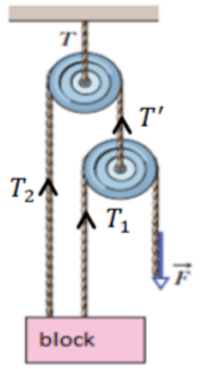
$$p = B\frac{dV}{V} = 2.8 \times 10^{10} \times \frac{0.23}{100} = 6.4 \times 10^{7} N/m^2$$

162, Final, Q11

Q12.

In **Figure 4**, a force $\vec{F}$ keeps a block of weight *mg* in static equilibrium. Considering all pullies as massless and frictionless find the tension *T* on the upper cable.

Figure 4



A) 1.3 *mg*
B) 2.1 *mg*
C) 0.50 *mg*
D) 3.2 *mg*
E) 0.27 *mg*

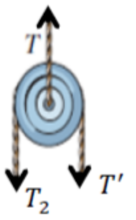
Ans:

$$T_2\,2R = TR$$

$$T_2 = \frac{T}{2}$$

$$T' \cdot 2R = T \cdot R$$

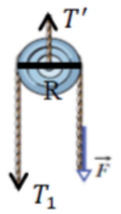
$$T' = \frac{T}{2}$$



$$T'R = T_1 2R$$

$$T' = 2T_1$$

$$T_1 = \frac{T'}{2} = \frac{T}{4}$$

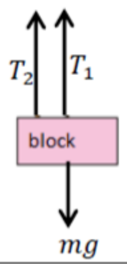


$$T_1 + T_2 = mg$$

$$\frac{T}{4} + \frac{T}{2} = mg$$

$$3T = 4mg$$

$$T = \frac{4}{3}\,mg = 1.3\,mg$$



162, Major 3, Q12

Q14.

In **Figure 5**, a man leans against a vertical wall that has negligible friction. Distance $a = 0.91$ m and distance $L = 2.1$ m. His center of mass is at distance $d = 0.94$ m from the feet-ground contact point. If he is on the verge of sliding, what is the coefficient of static friction between his feet and the ground?

A) 0.22
B) 0.42
C) 0.64
D) 0.12
E) 0.34

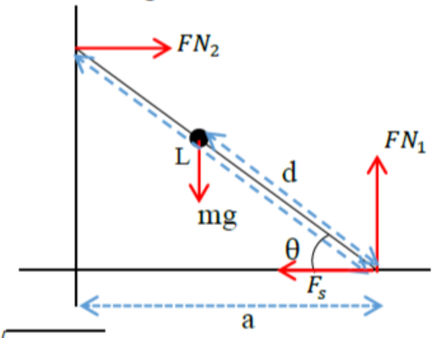
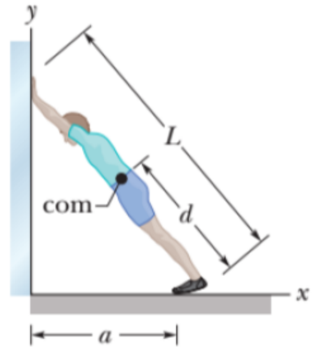


Figure 5



Ans:

Torque equation

$$mgd\cos\theta = F_{N2} \cdot \sqrt{L^2 - a^2}$$

$$\frac{mgd}{\sqrt{L^2 - a^2}} \frac{a}{L} = F_{N2}$$

Force equations,

$$F_s = F_{N2}$$

$$F_{N1} = mg$$

$$F_S = F_{N1} \cdot \mu_s$$

$$\mu_s = \frac{F_S}{F_{N1}} = \frac{F_{N2}}{mg} = \frac{mg\,da}{L\sqrt{L^2 - a^2}} \cdot \frac{1}{mg} = \frac{ad}{L\sqrt{L^2 - a^2}} = 0.22$$

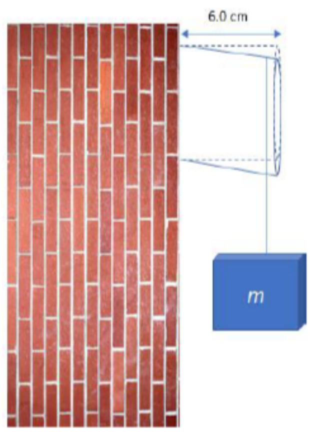
162, Major 3, Q14

Q15.

A rod 5.0 cm in diameter projects 6.0 cm from a wall as shown in **Figure 6**. An object of mass $m = 1.2 \times 10^3$ kg is suspended from the end of the rod. The shear modulus of the rod is 3.0×10^{10} N/m^2. Neglecting the rod's mass, what is the vertical deflection of the end of the rod.

Figure 6

A) 1.2×10^{-5} m
B) 2.4×10^{-5} m
C) 3.1×10^{-5} m
D) 5.4×10^{-5} m
E) 6.2×10^{-5} m



Ans:

$$\Delta l = \frac{F/A}{\Delta l / l} = \frac{F}{\pi R^2} \cdot \frac{l}{\Delta l}$$

$$\Delta l = \frac{F}{\pi R^2} \cdot \frac{l}{\sigma} = \frac{1.2 \times 10^3 \times 9.8 \times 6 \times 10^{-2}}{13.4 \times 2.5 \times 10^{-2} \times 3 \times 10^{10}}$$

$$\Delta l = 1.2 \times 10^{-5}\, m$$

162, Major 3, Q15

Prepared by Abul Lais/Dr M.A. Gondal

Q12.

What is the applied pressure to a solid copper cube in order to reduce its volume to 40 % of the original volume? The bulk modulus of copper is 1.4×10^{11} N/m^2.

A) 8.4×10^{10} N/m^2
B) 5.6×10^{10} N/m^2
C) 3.5×10^{11} N/m^2
D) 2.3×10^{11} N/m^2
E) 1.4×10^{11} N/m^2

Ans:

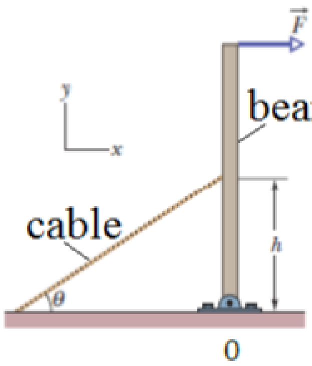
$$P = B\frac{\Delta V}{V} = 1.4\times10^{11}\times\frac{60}{100} = 8.4\times10^{10}\ \mathrm{N/m^2}$$

161, Final, Q12

Q13.

A uniform beam with a weight of 60.0 N and a length of 3.20 m is hinged at its lower end, and a horizontal force $\vec{F}$ of magnitude 50.0 N acts at its upper end, as shown in **Figure 9**. The beam is held vertical by a cable that makes an angle θ = 25.0° with the ground and is attached to the beam at height h = 2.00 m. What is the tension in the cable?

Figure 9



A) 88.3 N
B) 27.4 N
C) 44.1 N
D) 50.0 N
E) 61.3 N

Ans:

The system is in equilibium then $\tau_0 = 0$

$$-Fl + T\cos\theta\, h = 0$$

$$T = \frac{Fl}{h\cos 25} = \frac{50 \times 3.2}{2\cos 25} \approx 88.3\text{ N}$$

161, Major 3, Q13

Q14.

A rod that is 4.0 m long and 0.50 cm² in cross-sectional area is attached to a ceiling from one end. It stretches 0.20 cm by hanging a block to the other end. If Young's modulus for this rod is 2.0×10¹¹ N/m², what is the weight of the hanging block? (Neglect the weight of the rod)

A) 5.0×10³ N
B) 5.1×10² N
C) 8.0×10³ N
D) 2.0×10³ N
E) 2.1×10² N

Ans:

$$Y = \frac{\text{Stress}}{\text{Strain}} = \frac{\frac{W}{A}}{\frac{\Delta L}{L}}$$

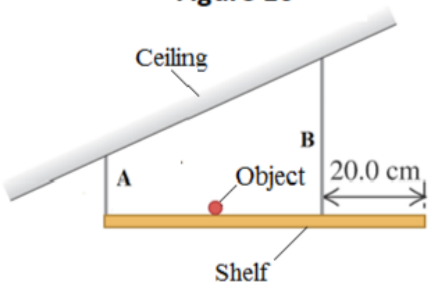
$$W = \frac{Y \times A \times \Delta L}{L} = 5.0 \times 10^3\text{ N}$$

161, Major 3, Q14

Q15.

A uniform shelf of weight 50.0 N and length 60.0-cm is supported horizontally by two vertical wires attached to the sloping ceiling (see **Figure 10**). The lengths of wires **A** and **B** are 25.0 cm and 75.0 cm, respectively. A 25.0-N object is placed on the shelf midway between the points where the wires are attached to it. What are the tensions T_A and T_B in wires **A** and **B**, respectively?

Figure 10



A) $T_A = 25.0$ N, $T_B = 50.0$ N
B) $T_A = 75.0$ N, $T_B = 75.0$ N
C) $T_A = 25.0$ N, $T_B = 75.0$ N
D) $T_A = 27.0$ N, $T_B = 25.0$ N
E) $T_A = 50.0$ N, $T_B = 50.0$ N

Ans:

The system is at equilibrium

$$\tau_z = 0 \Rightarrow T_B \times 0.4 - W_1 \times 0.3 - W_2 \times 0.2 = 0$$

W_1 *is the weight of shelf*

W_2 is the weight of object

$$T_B = \frac{W_1 \times 0.3 + W_2 \times 0.2}{0.4} = 50 \text{ N}$$

$$\sum F_y = 0$$

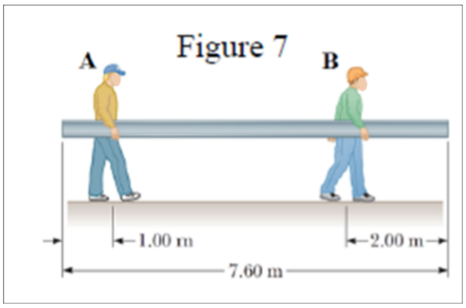
$$T_A + T_B - W_1 - W_2 = 0$$

$$T_A = W_1 + W_2 - T_B = 50 + 25 - 50 = 25 \text{ N}$$

161, Major 3, Q15

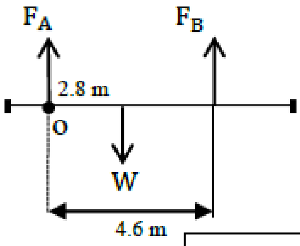
Q15.

A uniform beam, of length 7.60 m and weight 375 N, is carried by two persons (A and B), as shown in **FIGURE 7**. Determine the magnitude of the force that each person exerts on the beam.



A) F_A = 147 N, F_B = 228 N
B) F_A = 241 N, F_B = 134 N
C) F_A = 134 N, F_B = 241 N
D) F_A = 228 N, F_B = 147 N
E) F_A = 188 N, F_B = 188 N

Ans:



$$\sum \tau_0 = 0: -(W \times 2.8) + F_B \times 4.6 = 0$$

$$F_B = \frac{2.8\,W}{4.6} = 228\ N$$

No need to look at the rest of the answers!

153, Final, Q15

Q16.

A rod, of length 1.5 m and radius 4.8 mm, is hung vertically to a ceiling. A box of mass 85 kg is attached to the free end of the rod, stretching it by 2.5 mm. What is Young's modulus of the rod?

A) 6.9×10^9 N/m^2
B) 2.9×10^9 N/m^2
C) 3.7×10^9 N/m^2
D) 1.5×10^9 N/m^2
E) 4.3×10^9 N/m^2

Ans:

$$\frac{F}{A} = E \cdot \frac{\Delta L}{L}$$

$$\Rightarrow E = \frac{F \cdot L}{A \cdot \Delta L} = \frac{F \cdot L}{\pi r^2 \cdot \Delta L} = \frac{mgL}{\pi r^2\,\Delta L} = \frac{85 \times 9.8 \times 1.5}{\pi \times (4.8 \times 10^{-3})^2 \times 2.5 \times 10^{-3}}$$

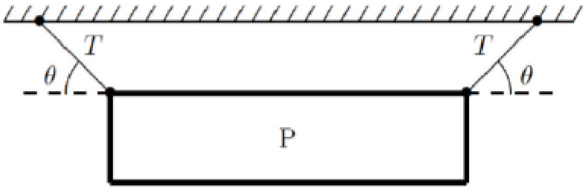
$$= 6.9 \times 10^9\ N/m^2$$

153, Final, Q16

Q13.

Figure 6 shows a picture P hanging by two strings making angle θ = 30° with the dashed horizontal line. If the magnitude of the tension force *T* of each string is 20 N, then the weight of the picture is:

Figure 6



A) 20 N
B) 10 N
C) 17 N
D) 40 N
E) 25 N

Ans:

$2T\sin\theta = W$

$(2)(20)\left(\frac{1}{2}\right) = W$

$20\ N = W$

152, Major 3, Q13

Q14.

A steel wire 2.3 mm in diameter with one end fixed to a ceiling stretches by 0.030% when an object is suspended from its other end. If the steel Young Modulus is 200×10^9 N/m^2, then find the mass of the suspended object.

A) 25 kg
B) 21 kg
C) 17 kg
D) 29 kg
E) 15 kg

Ans:

$\frac{F}{A} = E\,\frac{\Delta L}{L}$

$\frac{\Delta L}{L} = 0.03 \times 10^{-2}$

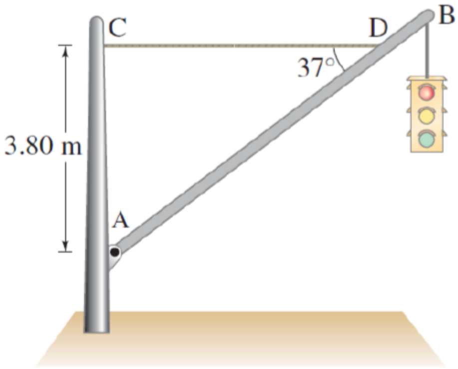
$\Rightarrow m = 25\ kg$

152, Major 3, Q14

Q15.

A traffic light hangs from a pole AB as shown in **Figure 7**. The uniform aluminum pole AB is 7.20 m long and has a mass of 12.0 kg. The mass of the traffic light is 21.5 kg. Find the tension in the horizontal massless cable CD

Figure 7



A) 408 N
B) 328 N
C) 570 N
D) 370 N
E) 608

Ans:

$$W_{TL} \times L_{AB}\cos\theta + W_{Pole}\frac{L_{AB}}{2}\cos\theta = TCA$$

$\Rightarrow T = 408\ N$

152, Major 3, Q15

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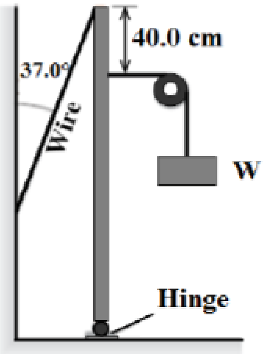
Q13.

A weight W = 100 N is supported by attaching it to a vertical uniform metal rod by a thin cord passing over a massless frictionless pulley, as shown in **Figure 9**. The cord is attached to the rod 40.0 cm below the top of the rod. The rod has a length of 1.70 m and its top is connected by a thin wire to a vertical wall. If the system is in equilibrium, what is the magnitude of the tension in the wire?

Figure 9



A) 127 N
B) 95.8 N
C) 39.1 N
D) 29.5 N
E) 166 N

Ans:

$\sum \tau_0 = 0$: where point O is the hinge

$W \times 1.3 = T \times 1.7 \times \sin 37°$

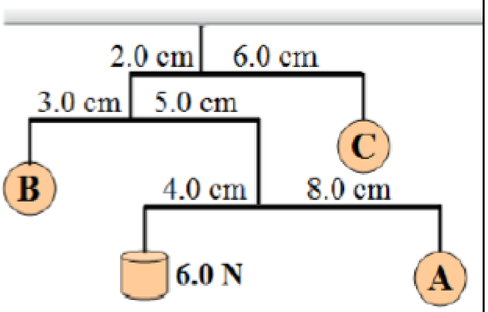
$\Rightarrow T = 127\ N$

151, Major 3, Q13

Q14.

Consider the assembly shown in **Figure 10**, where four objects are held in equilibrium by horizontal massless rods. What is the weight of ball C?

Figure 10



A) 8.0 N
B) 3.0 N
C) 15 N
D) 9.0 N
E) 18 N

Ans:

$6 \times 4 = 8\,A \longrightarrow A = \frac{24}{8} = 3\ N$

$5 \times 9 = 3\,B \longrightarrow B = \frac{45}{3} = 15\ N$

$2 \times 24 = 6\,C \longrightarrow C = \frac{48}{6} = 8\ N$

151, Major 3, Q14

Q15.

A wire has a length of 2 m, a cross sectional area of 0.01 cm^2, and is made of a material whose Young modulus is 5×10^{10} N/m^2. A force of 50 N is applied perpendicular to the cross section of the wire. What is the change in the length of the wire?

A) 2 mm
B) 3 mm
C) 1 mm
D) 4 mm
E) 5 mm

Ans:

$$\frac{F}{A} = E \cdot \frac{\Delta L}{L}$$

$$\Delta L = \frac{F \cdot L}{E \cdot A} = \frac{50 \times 2}{5 \times 10^{10} \times 0.01 \times 10^{-4}} = 2 \times 10^{-3}\ m$$

151, Major 3, Q15